PROCEEDINGS

OF THE

AMERICAN

Fish Culturists' Association,

AT ITS FOURTH ANNUAL MEETING,

FEBRUARY 9 & 10, 1875.

ROCHESTER, N. Y.
EVENING EXPRESS PRINTING AND ENGRAVING COMPANY.
1875.

OFFICERS, 1875-6.

R. B. ROOSEVELT, - - - - - President.
160 Broadway, New York City.

GEO. S. PAGE, - - - Vice-President.
10 Warren Street, New York City.

A. S. COLLINS, - - - - - Secretary.
Caledonia, Livingston Co., N. Y.

B. F. BOWLES, - - - - Treasurer.
Springfield, Mass.

EXECUTIVE COMMITTEE.

H. J. REEDER, - - - Easton, Pa.

M. C. EDMUNDS, - - - - Weston, Vt.

ALEX. KENT, - - - - Baltimore, Md.

W. F. WHITCHER, - - Ottawa, Ontario, Canada.

SETH GREEN, - - - - Rochester, N. Y.

NOTE.

One of the most useful objects of this association is the discussion of plans, theories, &c., at its annual meeting. It is impossible for the Secretary to report these discussions, but the Association has now authorized the employment of a short hand reporter, so that the next report will be printed soon after the meeting and contain a full record of all the discussions, &c., occurring during its progress.

REPORT.

The fourth annual meeting of the American Fish Culturists' Association was held on Tuesday, February 9th, at the office of George Shepard Page, No. 10 Warren street, New York. The meeting was called to to order at 11½ A. M. by the president, Hon. R. B. Roosevelt. Opening address was made by the President. Subject: Improvements and Progress in Fish Culture.

Secretary's Report read and accepted.

Treasurer's Report read and accepted.

Messrs. Blackford, Mather and Green were appointed as Committee on Nominations for the ensuing year.

Mr. Fred. Mather read a paper on Poisoning and Obstructing the Waters.

Recess—one hour.

The nominating committee presented the following report:

For President—R. B. ROOSEVELT.
For Vice-President—GEORGE S. PAGE.
For Secretary—A. S. COLLINS.
For Treasurer—B. F. BOWLES.
For Executive Committee—H. J. REEDER, M. C. EDMUNDS, ALEXANDER KENT, W. F. WHITCHER, SETH GREEN.

The report was adopted.

A communication from Thaddeus Norris on the Grayling was read by Mr. B. F. Bowles.

After discussions adjourned to 11 A. M. Wednesday, Feb. 10th.

Called to order at 12 M., on Wednesday, Feb. 10th.

Discussions by various members.

Mr. Blackford offered resolutions in favor of founding an Aquarium in New York city.

Recess till 2 o'clock P. M.

After recess, paper read by Samuel Wilmot.

B. B. Porter moved that the Association fix a price for Stock. Laid on table.

Paper read by Seth Green.

Paper read by Dr. Salter.

Mr. Page moved that Article II. of the Constitution be amended by making annual dues $3. Carried. Also, that the Secretary be empowered to employ a short hand reporter at next annual meeting. Carried.

Paper read by Prof. Gill.

Dr. Edmunds moved to rescind the motion of last year appointing the "Forest and Stream" the official paper of the Association. Carried.

Mr. Hallock spoke of the Grayling, &c.

Discussions by various members.

Moved and carried that the Secretary and Treasurer be appointed a committee to print Annual Report.

Thanks of Association voted to Mr. Page for use of room.

Adjourned to second Tuesday of February, 1876.

A. S. COLLINS,

Secretary.

TREASURER'S REPORT.

DR.

Feb. 10, 1874. Balance on hand	$ 18 83
Feb. 10 and 11, 1874. 28 new Memberships	140 00
Feb. 10, 1874. 4 Renewals	20 00
	$178 83

CR.

Feb. 20, 1874, Paid Argus Company, Albany, for printing Report of 1872	$37 50	
Jan. 1875, Paid Express Printing Company of Rochester. printing Report 1874	60 00	
Jan 18, 1875. Printing Circulars and Programmes	5 75	
Postage and Stationery	3 00	
Balance on hand, Feb. 9, 1875	$72 58	
		$178 83

B. F. BOWLES,

Treasurer.

CONSTITUTION.

ARTICLE I.—Name and Objects.

The name of this society shall be "The American Fish Culturists' Association." Its objects shall be to promote the cause of Fish Culture; to gather and diffuse information bearing upon its practical success; the interchange of friendly feeling and intercourse among the members of the Association; the uniting and encouraging of the individual interests of Fish Culturists.

ARTICLE II.—Members.

Any person shall, upon a two-thirds vote of the society, and a payment of three dollars, be considered a member of the Association, after signing the Constitution. The annual dues shall be $3.00.

ARTICLE II.—Officers.

The officers of the Association shall be a President, a Vice-President, a Secretary and a Treasurer, and shall be elected annually by a majority of votes; vacancies occurring during the year may be filled by the President.

ARTICLE IV.—Meetings.

The regular meetings of the Association shall be held once a year, the time and place being decided upon at the previous meeting.

ARTICLE V.—Changing the Constitution.

The Constitution of the society may be amended, altered or repealed, by a two-thirds vote of the members present at any regular meeting.

ANNUAL MEETING.

The following is an enlarged Report of the meeting, taken from the *Forest and Stream*, which was then the official organ of the Association:

The Convention of American Fish Culturists was called to order at 11 o'clock on Tuesday morning, at the office of its Vice President, G. Shepard Page. The President, Hon. Robt. B. Roosevelt in the chair. About 45 members were present, and before the morning adjournment a large number of names were added to the list.

Mr. Roosevelt took occasion to formally open the session by a brief address in review of the progress of Fish culture during the year that has elapsed since the previous meeting. He rejoiced that this great economic interest was everywhere advancing, and failing nowhere; success in every direction. Mr. Green's expedition to Michigan in quest of grayling and their eggs, was a success to be proud of. These fish had been transported to the New York State Hatch House at Caledonia, and under the supervision of Mr. Collins, these eggs have been hatched, and there are now fish three inches long, the product of this venture.

The Committee on nominations reported in favor of the old board of officers, who were duly elected.

Mr. Green in referring to Mr. Mather's paper on the impregnation of waters by deleterious matter, coincided with that gentleman, and gave an interesting description of his own experiences.

Dr. Edmunds alluded to the stocking of the Connecticut and stated that as far as his knowlege went no great loss of fish has ensued. He advocated making new and more stringent laws on the subject. Mr. Bowles gave an interesting account of his trip to the Au Sable, and the capture of the grayling. He read an interesting letter from Mr. Norris regarding the acclimatization of the grayling in Eastern waters. Mr. Bowles continued the recital of his experience on the Au Sable, and commented on the clearness of the stream, whose fish could be seen in the bottom in water of 20 feet depth. He camped each night in a different place, and found the fish so plentiful as to debar sport. He considers the grayling, although the flesh is white and tender, is not equal to the trout for the table.

With regard to grayling and trout in the same stream Mr. Green stated

that as the trout spawn in Fall and grayling in Spring, when the grayling are small and standing on their "tail ends" the trout will "go for him and take him sure."

Mr. Collins had experimented with grayling eggs and hatched them at same time as trout, when the grayling were so small and puny that they hid in the gravel, and it was difficult to say that there was fish there. The same food was used and they ate it before sack was entirely absorbed. The experiment as such was successful, and he succeeded in saving 90 per cent. Mr. Mather for many reasons prefers the grayling to the trout—and considers it a question as to which are best for the table; require less food and care than trout. The discussion was continued by Mr. Green and Mr. Mather. A telegram was received from Mr. Whitcher regretting his not being able to come, but the Dominion was worthily represented by Mr. Wilmot, who gave a most interesting description regarding his experiences, and referred particularly to the great increase of salmon of late years.

Professor Theo. Gill, of Washington, made some interesting remarks regarding the classification of fish, with reference more particularly to the grayling.

Dr Miller discussed the white fish of the lakes, their mode of feeding, etc., etc.

The subject of grayling was renewed by various gentlemen interested in the subject. Mr. Bowles said this fish was found in Bavaria with a mouth like a sucker. Mr. Hallock alluded to Capt. Bendire as having met grayling in Montana; he considered him good authority.

On motion of Mr. Bowles, the meeting adjourned to meet at same place and hour on Wednesday.

The association resumed its session on Wednesday, at the office of its Vice President, Mr. George S. Page, No. 10 Warren street, Hon. R. B. Roosevelt in the chair. Among the gentlemen present were H. J. Reeder Fishery Commissioner of Eastern Pennsylvania; T. B. Ferguson, Fishery Commisioner, Baltimore; Dr. William M. Hudson, Fishery Commissioner, Connecticut; M. C. Edmunds, Weston, Vt.; George Shepard Page, B. F. Bowles, Springfield, Mass.; C. Van Winkle. Walter Arnold, Toronto, Ontario; Prof. Spencer F. Baird, Washington; Dr. Milnor, United States Fishery Commissioner; Eugene G. Blackford; Prof. G. Brown Goode, of the Smithsonian Institute; A. S. Collins, Caledonia, N. Y.; Samuel Wilmot, Newcastle, Ontario; Seth Green, Rochester; A. G. Roorbeck; W. F. Parker, Meriden, Conn.; T. C. Banks, Charles Hallock, B. Phillips, Rudolph Hessel, Prof. Gill, Dr. Salter, N. Pike,

N. W. Park, Detroit; Charles B. Evarts, Vermont; C. H. Raymond, President of the Morris County Sportsman's Club; Prof. Henry Morton, Stevens Institute, Hoboken; Prof. Bickford, American Museum of Natural History.

The proceedings commenced with a recital by Mr. Reeder of his experiences with the two species of black bass known as *salmoides* and *nigricans*. A distinction has been made, he said, with regard to the geographical location of these fish; the general impression being that the *salmoides* are found in Southern waters, while the *nigricans* are confined to Northern rivers. Careful examination has led him to the conclusion that this geographical distinction was a mistake, although the difference between the two kinds of bass was distinctly marked. Alluding to the scarcity of this fish in the waters of Pennsylvania, which had originally been stocked from the Potomac, he remarked that he accounted for this circumstance in this way: In the early part of July, after the beds were prepared and when the spawn was there, they had severe storms, which flooded the streams and carried down mud and various kinds of debris. Their theory was that the sediment settled on the beds and killed the spawn. He would like to hear any suggestion which might be offered as to the loss of the young fish.

Mr. Seth Green thought that what Mr. Reeder had stated would be very likely to happen. That on the other hand, if the river had been overstocked, it was possible that the natural supply of food being exhausted the fish had eaten their young.

Mr. Reeder thought the explanation was hardly sufficient inasmuch as there was a large quantity of minnows and other fish on which the bass could feed.

Prof. Baird made a brief statement as to the action of the United States Commission. Their operations, he said, had been principally connected with shad and salmon. Shad were quite plenty both in the Hudson and Connecticut rivers, and they have been able to transfer a large number of fish to the West. The aggregate distribution was between two and three millions, some of which were carried to Ohio, Michigan, Wisconsin, Iowa, Minnesota and Massachusetts. The German Government had forwarded them 250,000 eggs of the Rhine salmon, through Mr. Hessel. but nearly all of them died, and in the same way their attempt to introduce American shad into German waters had also failed. The eggs were forwarded in charge of Mr. Mather and Mr. Anderson, but after eleven days they all died. The salmon stations in California and in Maine had, Mr. Baird said, been considerably enlarged. About 6,000,000 of eggs had been taken in the McCloud River, of which 1,000,000 or thereabout had been turned into the Sacramento River.

About 2,500,000 of California salmon of last year's production were now in the streams for which they were intended. The Bucksport settlement, he explained, had also been more successful than usual.

Mr. Green, in referring to the failure of the New York Commission to carry the shad to Germany, stated that the boxes in which the eggs were placed were made of tin and zinc, which formed a battery, and the eggs, he believed, were killed by the acid thus created.

Mr. Reeder communicated to the association the substance of a communication from Mr. Clark, of Michigan, with regard to the hatching of whitefish. He had retarded the hatching of whitefish for 135 days by the use of cold water and ice, when necessary, and it occurred to him [Mr. Reeder] that this system might be made effective in the transportation of fish across the Atlantic. After they were safely transported, they might be then hatched.

Mr. Green described the way in which the whitefish deposited their spawn, which was, in effect, that they scattered it broadcast, while on the contrary, he said the salmon trout deposited it in beds, and tried to cover it up.

Mr. Reeder, recurring to the subject of retarding the hatching of whitefish, said that Mr. Clark's plan was to let the water cool to the temperature of the atmosphere, and then let it run over the eggs, and, if necessary, to cool it with ice.

The subject of establishing an Aquarium in New York, on the principle of that at Brighton, was introduced by Mr. Eugene G. Blatchford. He represented that the study of ichthyology was attended with difficulty, and urged that an opportunity should be given for observing the habits of fish in their natural element. This matter had been advocated in the *Times*, *Appleton's Journal*, and *Forest and Stream*, and, in hope that it would be favorably entertained, he would present a resolution on the subject. He then moved a resolution expressing in effect the belief of the Fish Culturists' Association that an Aquarium in the city of New York would be a great benefit to science generally, and ichthyology in particular, and giving its favorable countenance to any public or private measure in that direction.

Mr. Ward, of *Appleton's Journal*, said that having heard that Mr. Saville Kent had severed his connection with the Brighton Aquarium, he wrote to Mr. Kent with the view of getting his opinion as to the establishment of an Aquarium in Central Park. He [Mr. Ward] thought if they could obtain Mr. Kent's services, and the endorsement of the public, the matter would be fairly in the way of progress. The idea he had in his mind was to agitate the question in New York so that some gentleman might be willing to come forward and endow an aquarium building in

Central Park. The financial panic then intervened, and everybody was calculating what money he had to keep rather than what he had to spend. As far as he knew there was no special scheme on foot.

Prof. Baird thought a stock company would be desirable as well as profitable, although it should be one of the public institutions of the city. The stocking of such an aquarium would be a very simple matter. He would willingly give the use of all his trawls, nets, etc., used in his coast work, and could furnish an abundance of specimens. The Central Park authorities, he believed, would facilitate the matter by every means in their power, and other attractions might be added to the aquarium.

Mr. B. Phillips, in advocating the establishment of an aquarium, referred also to some of the discussions which had occurred the previous day in relation to the impregnation of water to such an extent as to alter the character or flavor of fish. This appeared to him to be an abstract science, something in the nature of the dilettanteism of pisciculture. His friend, Mr. Blackford, however, in asking for an aquarium, only asked for what would be of the greatest possible utility in the study of ichthyology.

Mr. Blackford's resolution was unanimously adopted by the association.

Mr. Wilmot, of Ontario, Canada, read an interesting collatement from reports which he had submitted to the Canadian Legislature on the subject of fish culture.

A resolution was here introduced with the view of binding fish culturists to sell spawn at certain rates, for the purpose of uniformity of prices; but most of the members of the association were opposed to it, and it was directed to be laid on the table.

Mr. Green submitted some remarks on the subject of re-stocking our used-up streams.

Dr. G. H. Colton Salter, for many years United States consul at various ports in China, entertained the association with a recital of some of his experiences with the fish and fishing in that kingdom.

Prof. Gill, of the Smithsonian Institute, furnished the association with a scientific discourse concerning the divisions of the various families of fishes found in American waters. With reference to the matter first brought forward by Mr. Reeder as to the geographical distinction of the species of bass known as the *salmoides* and *nigricans*, he said that in his experiences the latter were found even further South than the *salmoides*.

During the day several oil paintings from nature, of trout, salmon trout, California salmon, and grayling (the work of Mr. Robert Wiseman), were exhibited.

After some formal resolutions, the thanks of the association were tendered to Mr. Page and the other members of the firm for placing the room at the disposal of the society.

The meeting then adjourned.

RESOLUTIONS OF E. G. BLACKFORD.

GENTLEMEN: It seems to me that the present assemblage, composed of gentlemen all devoted to fish culture, many of them representing important State interests, some of them distinguished for their great scientific acquaintance in natural history,—it strikes me that it might not be out of place to introduce before you a subject which I know some of you have thought of before, and that is in regard to founding an Aquarium in the City of New York. It must be manifest to you, that icthyology—its practical study—is surrounded by certain difficulties, which do not attend researches in zoology. It may be troublesome to obtain live animals, but once a collection made, can be maintained in pretty nearly its natural normal conditions; but with fish it is different: their preservation depends entirely in other and more complex media. We do not possess, all of us, those opportunities Professor Baird and other gentlemen have, of going to Wood's Hole or Noank, and watching the habits of fish in their native element; and even if we had, I doubt if we ever could have made such brilliant discoveries as these gentlemen have given us. I think we must all agree that it is essential for a better acquaintance with icthyology, that there should be an Aquarium, not only for practical but for scientific research. I take the liberty of proposing that Professor Baird should give us some ideas on this subject. In the *Times* and in *Appleton's Journal*, there have appeared a number of ably written articles in regard to the founding of an aquarium in New York, and it seems that the trouble and expense of an aquarium would not be very great. I believe that in time the erection of an aquarium in this city, the rival of the one in Brighton, is quite possible. If my views meet with a response, I should be glad to propose the following resolutions. What I would like, is simply the concurrence of the Fish Culturists' Association, and their endorsement. My resolutions would be somewhat as follows:

1st. That the Fish Culturists' Association believe that an Aquarium in New York would be of the greatest benefit to science generally, and to icthyology particularly.

2d. That the Fish Culturists' Association fully endorse any private or public measures which would tend towards the establishment of an Aquarium in New York.

PRESIDENT'S OPENING ADDRESS.

GENTLEMEN: In calling the Annual Meeting of the American Fish Culturists' Association to order, I have the pleasure of congratulating you upon the progress which has been made during the past year. This great economic interest, the artificial production and propagation of fish, has been steadily advancing since our last meeting. Success has crowned all intelligent efforts; failure has not interrupted the progress or endangered the final result; while operations have been extended in several new channels, and many fresh and valuable discoveries have been made. A wider and more general interest has been awakened among the people, commissioners have been appointed in States where the subject had been hitherto neglected, and the public are rapidly becoming aroused to the importance of the work we have undertaken.

For the New York Commission of Fisheries, about which I may be expected to say a few words in detail, a most substantial gain may be reported, and a most flattering augury for the future. Not only have all the former methods of procedure been enforced and extended, but several new attempts have been made. Early in the spring of the year, Mr. Seth Green was dispatched to Michigan to procure, if possible, some of the spawn and mature fish of the American grayling, a variety almost, if not quite, unknown, both to sportsmen and naturalists in our country until lately. There is a difference of opinion among fish culturists as to the value of this species, both in an economic and a sporting view, some contending that it is inferior to other of our well-known varieties, and more difficult to raise; and others claiming that, as it spawns in spring at a season of the year unusual among its class, and as it is in excellent condition in the fall, when the finest ordinary fresh-water fish are not to be taken, it will be a valuable addition to the yield of eastern waters. No one, however, can dispute that it is a most interesting subject of study, equally to the ichthyologist and to the fish culturist.

Mr. Green was not so fortunate as he hoped to be, arriving rather late at the river inhabited by these fish, and only procured a limited number of spawn and a few mature specimens. These were enough, however, for the experiment, and with his usual care in transportation, he carried them to the State Hatching House in New York from their home in the waters of Michigan, with the loss of only two. They were then placed in the charge of Mr. Collins, who kindly offered to superintend their management, and who hatched the ova very successfully. They grew rapidly, and in them we have the nucleus for extending the experiment

as far as may hereafter seem desirable. So not only is it settled that grayling exist in the waters of the United States, but that they may be cultivated in the same way as trout, and introduced into most, if not all, of our ordinary trout streams.

Another rare fish which is this year being hatched artificially for the first time, is the blue-backed trout of the Rangeley lake of Maine, the *salmo Oquossa* of naturalists. This variety is supposed to have but a limited range of habitat, although it may yet be more generally found in the remote lakes of Canada. Little, however, is known about it or its habits, except that it spawns in October, appearing in the shallower water for that purpose in vast numbers, and that it passes most of its time in the deepest parts of the lake, spending the warm weather there, and returning thither as soon as the eggs have been deposited at the spawning season.

Learning that the Commissioners of Maine had obtained some of the eggs of the *salmo Oquossa*, and were willing to dispose of a portion, the New York Commissioners purchased five thousand, and are now engaged hatching them. Unfortunately, the ova did not reach the hatching house in very good order, nearly half of them being found to be worthless; but there are enough left for a beginning, and this fish may soon to be added to our list of home production, if it shall be found on trial to be of sufficient value to warrant its general introduction. In two aspects it may prove of importance: firstly, for its direct value in the market, and secondly, as food for other fish, it being supposed that the great size of the Rangeley trout is due to their feeding on the blue-backs.

The New York Commission made a further but unsuccessful attempt to hatch sturgeon. These fish once abounded in the Hudson River, and were an acceptable and important, although inexpensive, object of food. Their flesh is rich and oleaginous, of a deep yellow color, and somewhat resembling meat in taste. Of late years their number has been steadily decreasing; their eggs are sought after, and converted into *caviare*. But to be used in this way they must be immature, as when they are thoroughly ripe they are separate, and cannot be preserved. For fish-cultural purposes, however, they are needed in their ripe condition; and as each spawner contains a vast number, a million or more, of eggs, a few parents only would be needed. Unfortunately, no mature fish were obtained, although the fishing stations were watched assiduously—quite an unusual occurrence, as we were assured by the fishermen. Next year, however, a different result may be expected, and the propagation of sturgeon may be commenced.

These were all more or less experiments, offering problematic advantages; but the regular operations of the Commission were pressed as

energetically as ever under the able superintendence of Mr. Seth Green, to whom fish-culture owes such great obligations. White fish, salmon trout and shad were hatched in many millions. Black bass and Oswego bass, with their allied species, were distributed. Barren lakes and streams were re-stocked, no application being denied, and no demand not being filled to the utmost. The returns from these proceedings in previous years began to make themselves apparent. From every direction came reports that waters which had long been unproductive and worthless, were beginning to yield, and, in some instances, were already yielding abundantly. Wherever fish had been placed, they seem to have thriven, and the care taken to select the proper varieties for each lake or stream was rewarded.

These operations were not experiments, and to them the attention of the New York Commission was mainly directed, although some experiments appeared to promise well. The shad, for instance, which were placed in the Genesee river lived and grew to a fair size. Many had been taken of a pound weight, and a few even much larger. But the question was not yet answered as to whether they would spawn when wholly confined to fresh water. In protecting and hatching artificially impregnated ova, as well as in re-stocking streams which have been depleted by neglect or overfishing, the fish-culturist acts with certainty and confidence; but the acclimatization of new varieties to unaccustomed waters is always an uncertainty.

This, gentlemen, is in a few words a report of what has been done in the State of New York. I think it is encouraging. I know that as much or more has been effected in other States either under their Commissions or by private enterprise.

POISONING AND OBSTRUCTING THE WATERS.

BY FRED. MATHER.

From all over the land there is a murmur of complaint about the pollution of our creeks and rivers by manufacturing companies, dyeing establishments, saw mills, and the like; and while the general Government, States and individuals are working to re-stock our nearly exhausted rivers, lakes and streams, this pollution is allowed to go on unheeded and unchecked.

The murmur is gradually getting louder, and we will ere long, we

hope, reach the ears of our legislators in a tone loud enough to attract their immediate attention.

The flowing waters, and the large lakes are part of our public domain, and no man, or body of men, should be allowed to defile them; yet it has been done almost without protest for years past, and will continue to be practiced for years to come, unless the attention of the people is called to it in a manner that shows to them that their vital interests are affected by it, and that the efforts of their Fish Commissioners, who are trying to increase their supply of food, are being continually thwarted by the greed of a few men, who, to save themselves the expense of draining their poisonous refuse into the soil, where it might be rendered harmless in Nature's laboratory, make sewers of our brooks and rivers. So also the dweller on small streams is cut off from his supply of fish, which have always ascended his brook, by the miller who has just built a dam across it lower down. The State of New York has a law covering the latter case, but it needs enforcing sadly. It provides that "every person building or maintaining a dam upon any of the fluvial waters of this State, which dam is higher than two feet, shall likewise build and maintain during the months of March, April, May, September, October and November, for the purpose of the passage of fish, a sluiceway in the said channel at least one foot in depth at the edge of the dam, and of proper width, with four inch-square cross pieces upon the bottom of the sluiceway three feet apart, which sluiceway shall be placed at an angle of not more than seven degrees, and extending entirely to the running water below the dam, and said sluiceway shall be protected on each side by an apron at least one foot in height, to confine the water therein."

The penalty for non-compliance with this act is $25 for each month's violation.

This is a recognition of the rights of the people to have unobstructed passage for their fish; but in regard to poisoning, the New York law says:—

"No persons shall place in any fresh water stream, lake, or pond, without the consent of the owner, any lime or other deleterious substance with intent thereby to injure, poison, or catch fish, nor place in any pond or lake stocked with, or inhabited by trout, bass, pike, pickerel or sunfish, any drug or deleterious substance with intent to destroy such trout or other fish."

This is a "misdemeanor," and is punishable by $100 fine in addition to any damage done. The weakness of this section is in not including rivers, in the words, "*with intent to destroy such trout or other fish.*"

Any vagabond can get out of this by declaring that he only wanted to

kill vegetation, snakes or turtles. The amendments of 1872 provide, sec. 18:—

"No person or corporation shall throw, or deposit any coal tar, refuse from gas houses, or other deleterious substances, or cause the same to run or flow into, or upon any of the rivers, lakes, ponds or streams of this State, under a penalty of $50 for each offence, in addition to liability for all damage he may have done: but this section shall not apply to streams of flowing water which constitute the motive power of the machinery for manufacturing establishments, where it is necessary for the manufacturing purposes carried on in such establishments, to throw from, or run the refuse matter and material thereof into such stream."

The last clause emasculates the whole section, and makes a mockery of all legislation on the subject. I have seen the dead fish in the bayous (or creeks as they are improperly called) below Albany on the west side of the Hudson from the refuse of the Analine works, which came in through the city sewers.

It is a hard matter to poison a large river like the Hudson, and do it thoroughly from end to end, a fact that we may be devoutly thankful for; but in times of low water in that river I have no doubt that the baleful influence of Albany's dye and chemical works extends to the shad hatching grounds, ten miles below.

In the report of the Maine Fishery Commission for 1873, page 13, they say, in speaking of the shad fishery on the Kennebec:—

"A careful exploration by Mr. Brown for the spawning ground of the shad at Topsham and Brunswick discovered that they had been driven from their old haunts by the refuse turned into the river by the Perkins paper mill."

Last season while at Holyoke, Mass., I made a few enquiries to learn if possible to what extent, if any, the shad grounds on the Connecticut were affected by the refuse of the mills immediately above, on the same side of the river with them. Being then engaged in transporting shad fry from there to the tributaries of the Mississippi and the Great Lakes, for the United States Fish Commission, I had no opportunity to investigate the effect of the poisons, but developed the following facts in regard to their amount. Just below the great dam, and within five hundred feet of the fishway, are three large factories, the first of these is the Carew Paper Company; second, the Hampshire Paper Company; third, the Glasgow Gingham Company. The first two discharge from one to two tons of chloride of lime per day, each; while the amount of dye stuffs, etc., emptied into the river by the latter will probably make the entire amount of villainous ingredients foot up to between four and five tons per day of chloride of lime, acids and dye stuff. The fishery and spawn-

ing grounds are about half a mile below, in a bend where a greater portion of this must be carried. This, in connection with from *thirty to forty miles on the other side of the river*, which are discharging (or were in July last) into the canals, or river, the same substances in greater or less quantity, *must* have a terrible effect upon the fish, especially those yet in the embryo stage.

A well informed angler says:—

"They say that fish that are poisoned with chloride of lime will recover; but it is not so, except perhaps in very slight cases. There is so much water in the Connecticut that a large fish may get out of a poisoned streak in a short time, but not so with newly hatched fry, who might be caught in it, and who would have to swim perhaps several times their own length to find pure water."

That the substances mentioned are deadly poisons to fish is very evident; the only thing to be taken into consideration, is the amount of such poison as compared to the volume of water and its consequent dilution. On the subject of ordinary sewage from cities, I am not prepared to speak; by "ordinary sewage" please understand the drainage of private houses, water closets, wash of streets, and other things, not including factories using dyeing and bleaching chemicals. That this is regarded as poisonous to fish in England is evident by the following article from "*Land and Water*," of Nov. 14, 1874:—

"CRAY RIVER POLLUTION.—Vague rumors have reached me (not through an exactly official channel) that the sewage now running into the Cray is to be carried in a sewer or sewers to an outfall about two miles north of Dartford. Now, though I am in no way connected with, and have no claim to the attention of the sanitary authorities who have the matter in hand, I do hope that they will bestow some thought on what follows before taking such a course as this. Next session, there is every reason to believe that Parliament will pass a comprehensive measure for the prevention of pollution of rivers. Is it not probable that this bill will deal with mouths and estuaries as with upper waters? If so, will it not include Dartford (and Barking too, for that matter)? This seems to be the only just, straightforward way of dealing with the matter. It would in the case of the Barking outfall involve great alterations, and many different interests would be concerned in such a change; but why not? The end of this note may supply a solution of this question. Otherwise, no one would know where the functions of the Act would terminate. Every interested person would view the question through his own spectacles, and there would be no end of litigation. I say again, as I have already said in your columns, either use your sewage on land *in*

season, or precipitate it altogether, but do not let it foul water, either in lake, river or sea. There is no excuse for harboring refuse and beastliness about us, as there are several really practical and workable processes available for the treatment of sewage and refuse; notably the Universal Charcoal and Sewage Company. This company utilize by carbonization all vegetable and animal refuse, as street sweepings, etc., of towns and villages, and with that they state that they are able to precipitate the sewage so thoroughly that fish will live for months in the effluent water. Knowing the powers of charcoal, I quite believe all this. Moreover, the manure produced by this process is very rich, as is attested by scientific evidence of no mean order. This company are quite prepared, on the one hand, to get rid of all offal and unsalable street refuse; and on the other, to precipitate sewage so that the effluent is perfectly harmless. Now all this is very satisfactory, and demands a fair and impartial trial by some really expert scientist. Be this how it may, and not for a moment laying claim to any such title, if the company think fit to send me some of their charcoal I shall be very happy to put it to a severe test, and acquaint your readers with the result. In speaking thus of the above company, I mean by no word of mine to disparage any others; many are very valuable, and many experiments must be made on various kinds, and samples of sewage, in order to determine that which may be most applicable in individual circumstances. All I would say to everybody at work at sewage is, don't go and run it away down rivers, estuaries or seas; do something with it, or at any rate try every experiment before doing so. Sewage varies, and must be treated accordingly. For my own part, I do not believe that taking out and utilizing the Cray sewage would cost one shilling more (on both sides of the river) than to run it out into the outfall at Dartford. For instance, I know that within about half a mile on either side of this house, there is one house on one side and eight or nine on the other. All these can use either earth or charcoal; but must be made to do so—prejudice is so strong in favor of old methods. What we want is a pure river and river bed; this latter we can hardly expect for some time under any circumstances, as there is a very great and dense mass of filth in the river, but, if all unite, north and west, and without petty considerations of self interest, and without any spirit of Bumbledom, we may have it at last."

Another writer in the same paper says:—

"The surface of our rivers appear as if covered with oil or other fat substance. May this not be caused by the manures now put on the land, making the fish so shy and timid? It would be worth the while of our Fishery Commissioners to inquire into it while at the pollutious inquiry."

This subject is new to us, but is well worthy our attention. So far, we have bent our energies to producing fish in vast numbers, with but little consideration of the many delicate conditions necessary to their future growth; and in my opinion, if the rivers were as pure to-day as when our forefathers landed on Plymouth Rock, there would now be the same immense shoals of salmon, shad and alewives ascending our rivers that there were then, multiplied tenfold by our methods of artificial propagation.

STOCKING DEPLETED WATERS.

BY SETH GREEN.

GENTLEMEN:—I have been worrying my brain for the last twelve years in studying out the art of fish culture and the best way to stock our depleted waters. In the year 1837 I commenced fishing as a business, and followed it until 1860. I had sometimes as many as one hundred men in my employ in taking and selling fish. I did my fishing with all kinds of nets and lines, and in all kinds of waters, and had as good success as any other fisherman in those days. When the weather was so that any boat could live on the lake, my boat was sure to be there with an early start. I have been capsized, and have ridden some time on the bottom of my boat. I did not like it, but preferred it to not having anything to ride on. I have rowed eighteen hours without getting off my seat, and pulled every stroke for my life. The boat had stern way on her six hours of the eighteen, with every man pulling his best. I was fishing in Lake Ontario at the time, at a point four miles above the mouth of the Genesee River. We started from shore at three in the morning, in an open boat twenty feet long and seven feet beam; myself, two men and a boy comprising the crew. The lines were set twelve miles out in the lake, and I was fishing for salmon trout, with set lines. I reached my buoy at seven o'clock that morning, and had taken up four miles of line when it blew so hard that the line broke. I started for shore with the wind dead ahead and blowing a gale, and reached there at three o'clock the next morning, landing at Braddock's Bay, three miles from my cabin and forty rods from a fish shanty. I sent one of my crew to wake up the men; in about five minutes more I sent another man, and in about five minutes more myself and boy started for the same shanty. I

had got about half way to it when I found one of my men lying on the sand fast asleep in a pouring rain. I got him to his feet, went to the shanty, and found the door open and the legs of my first messenger sticking out over the threshold, and he, too, was fast asleep. After pulling the latch string he had fallen in without waking the fishermen in the hut. We got the latter up, and stowed ourselves away in their warm beds, and that was the last any of us knew for the next twelve hours. I took, or caused to be taken, from a half ton to three tons of fish daily for twenty years of the early part of my life, and think I know all the devices for taking fish, from a pin hook to a pound net. I have used all of them, and have probably done as much toward cleaning out the waters of this State as any man, and that is the reason, I suppose, why people think I should know some thing about restocking these waters. The great secret in this work is in putting fish in the waters suited to them. Many bodies of water are suited to kinds of fish that never were in them before, but all waters are not fit for all kinds of fish, and you might better put them on the land than in water not suited to them; they will not thrive. The waters into which you put fish must have the right kind of food for them, and you must know if it is there, and it is a mistaken idea that some people have that fish will live on water; they cannot any more than you can live on air.

Many of the States have fish commissioners, and this State has three—Gov. Seymour, Robt. B. Roosevelt and Edward M. Smith. I am their superintendent, and being one of the oldest in the business and having probably seen as much of it from the bottom to the top as any, I take the liberty to give you my opinion of what kind of men you want for fish commissioners. You want wealthy, public spirited men—three such men. The superintendent must be a practical fisherman, who knows how to take all kinds of fish in all sorts of inland waters, and if you can get a man who is a fish culturist as well as a fisherman, all the better. If you have to employ a man who has but one of these qualifications, the fisherman is the more valuable. You must know how to take fish to have them for stocking your waters. I, of course, think our State the model one in these respects. The commissioners and myself have been operating together for the last six years, and never have had any discord that we did not settle at the time. We get together once a year, lay our plans, and then live up to them. There was a time when I thought I knew more than they did about the business; but they have caught up with me and I don't know but what they are a little ahead, for they know all that I do, besides what they have learned from everybody else. We have now practical knowledge enough to stock all our waters, but the great secret is to do it in the right way. All our used up shad rivers can

surely be stocked again, and become as productive as in their best days; and the quicker it is done the better, for they are getting poorer every year.

In the year 1868 I was in Washington, and hatched a few shad in Gen. Spinner's office. I told him I could stock the Potomac with young shad, and in three years they would be as plenty in that stream as they ever were. He asked me how much it would cost. I said $2,500 would do it. He said he could get an appropriation from the Government, and we went to the Capitol and told the members our story. They presented a bill, and one of the members objected to it; that was the end of it, and Gen. Spinner was one of the maddest men I ever saw. He said it was the greatest calamity to the country that had happened in this generation, and so it was. If he had obtained the $2,500 appropriation the Potomac River would to-day be the greatest shad river in the world. At that time I was the only man who had ever hatched shad to know anything practically about it, and did it all with my own hands. Now it is different. I have eight practical men, and every one of them is able to run a shad hatching establishment. There is but one other in the country who can, and that is Charles Smith, who was with me at Holyoke in 1867. Shad hatching is a trade by itself. A man may know how to hatch other kinds of fish, and make a perfect failure in hatching shad. He may know how to hatch shad in a running stream, and fail in tidal waters; but there is enough known about it now to restock all our shad rivers, and in a few years make them equal to their best days, if the work is well arranged. The next great thing to be done is to stock all our larger lakes with salmon trout and whitefish. We have been hatching these for the last seven years, and I know that our great lakes can be abundantly stocked in a few years. The Canadian Government would probably assist, as they have eminent fish culturists, who know the benefit both countries would derive from the work. Even if one side was willing, and the other not, the undertaking would pay millions of dollars to either. Let each side, then, go to work on its own hook, for as soon as one side begins the other will surely follow. If we begin first, we cannot do so much that the Canadians will not try to out do us, and *vice versa*. Much valuable time is lost by waiting.

Three years ago I took as many salmon trout spawn with four men as I secured last Fall with twelve, and if the fish decrease in the same ratio for a few years more it will take a long time to stock the lakes again. The black, Oswego, and rock bass, and the wall-eyed pike are valuable for stocking our inland waters. It is well enough to exchange spawn with the old countries without going to much expense in doing it. We have as fine varieties of fish in this country as there are in any other. A

good deal has been said about the carp for stocking some of our waters; but if I am rightfully informed it is a coarse fish, about equal to our mullet. The Oswego bass is much to be preferred for the table, is a fast breeder, and will live in any waters that the carp can exist in. We want done only what we know is practical, and do not want expensive experiments; our commissioners say to us, we want to expend the people's money for what we know to be for the greatest good to the greatest number, and there is plenty of work to do before we can spend time in experiments. Let us stock our waters with fish; there is no trouble doing it, unless we switch off to some other work which does not belong to the one we have commenced. If we turn aside we shall soon find that the people will refuse appropriations, and the work will be stopped, for there is not a dollar of the people's money spent but some one discovers what it was expended for, whether for the purpose to which it was appropriated or not. Let us keep the confidence of the people.

When I went to the Connecticut and Hudson rivers and told the people I was going to hatch shad eggs, and make shad plenty and cheap, I was hooted at; being looked upon by some as a lunatic, and by others as a rogue. Mr. James Mull, who owns the fishery where we do our shad hatching for this State, told me last Summer that he sent a dozen gentlemen to talk with me and see if they could make out what kind of a character I was. All thought I was insane or an impostor, and I was treated as such the first year on the Hudson and Connecticut rivers. Some of my visitors told Mr. Mull on their return, that I might be insane, but was no fool. It is different now, and they don't hoot at me, but take my hand with a warmth that gladdens my heart. I have a set of men with me who are practical fishermen and practical fish culturists. I think they are as good as any in the country, and are capable of superintending operations in any State. They are not writers, but are honest, and have education enough to keep an account of all they do. They are deserving of better places and more wages than our commissioners can afford to pay them. They have been taught economy, and practice it.

AQUACULTURE AND FISH PROTECTION.

BY SAMUEL WILMOT, NEWCASTLE, ONTARIO.

In submitting this paper, on some of the points in fish culture, to the American Fish Culturists' Association, now assembled, I shall endeavor to be as brief as possible; yet there are so many interesting subjects connected with the science of aquaculture that it will be almost impossible to control the matter without affecting its general interests. My object at this time, however, will be to touch upon the importance of the science as a whole, and to show why there should be judicious laws passed to preserve fish at certain seasons, and also endeavor to answer the question so frequently put by the skeptically inclined, "Why resort to artificial breeding of fish; and why not allow them to breed in their own natural way?"

When we consider the importance of this new branch of industry, both as a means of producing cheap and wholesome food, as well as individual and general wealth among the people among whom it has been introduced, it is gratifying to find that a knowledge of its principles is gradually becoming more and more generally diffused, so that we may safely look forward to the time when no country can be found wherein the science of pisciculture is totally neglected.

Independent of the pleasure and instruction which fish culture, on a small scale, has afforded to amateurs and others who have employed their time and means in adding another luxury to their tables, much profit has been realized by utilizing springs and small streams of water on private properties. And in both the old and the new world we may see that the various governments have chosen the most scientific and practical men of the day to find means whereby the vast areas of water, which cover three-fourths of the earth's surface, may be made to produce inexhaustible supplies of food and riches; so that, through man's intelligence and industry, aquaculture may become the successful rival of its sister art, agriculture.

The introducing and acclimatizing of many of the better and scarcer kinds of fish has been achieved through the instrumentality of this new agent. It is now an indisputable fact that some of the kinds of fish that were transported in the egg state from Scotland to Australia and New Zealand are found to be acclimatized to the waters of the Southern Hemisphere, where they were hitherto wholly unknown.

In a similar manner fish fry and eggs from the waters of the Atlantic

coast have been successfully carried across the continent by the overland route, and planted in those of the Pacific coast, and *vice versa*. Through the praiseworthy efforts of Prof. Baird and Livingston Stone, the salmon of the Pacific coast are being sown broadcast into the streams of the Eastern States of the Union. In Canada, also, there has been introduced certain hitherto unknown fishes from Britain. These efforts, successful in their application, are only the forerunners of what will yet be largely brought about through the study of practical fish culture. And no doubt when the science becomes more generally diffused, the importation and exportation of the more valuable kinds of fishes will form no inconsiderable traffic between countries whose interests may require an improvement in that branch of commerce.

France has always taken a very great interest in the artificial propagation of fish as an easy means of producing cheap food for her people. The immense grounds which were laid out, and the buildings which were erected at Huuningue, are strong and convincing evidences of this fact. And although by the fate of war the province in which the large French piscicultural works were established was ceded to Prussia, she has since that period commenced again the founding of another fish breeding establishment in another portion of her territory. Prussia is also extending the works which came into her hands by the act of cession.

In Great Britain the enterprise has been entered into with great zeal, and with marked success, large fortunes having been amassed by individuals from the increased productions of old fishery grounds through artificial methods of propagation. In other countries of Europe, and in Asia, fish culture is now successfully adopted also; and throughout almost the whole of the old world the science is making its beneficial effects felt by the masses of the people in the greater supply of wholesome food.

Nothing, however, has given a stronger impetus to fish culture at the present time than the hearty and zealous manner in which the local legislatures of many of the States, as well as the Federal Government of America, have entered into the work of encouraging the growth and improvement of the piscine wealth within their territories. Not only have large grants of money been made by individual States to assist their fishery commissioners in restocking depleted waters, but the Federal Government at Washington makes very liberal grants from the treasury to aid in what has been considered a great national work.

As a result of the united efforts of the State legislatures and General Government, a large salmon breeding establishment has been built in Maine, under the superintendence of Mr. Atkins, which has admirably answered the purpose for which it was constructed, and quite equal to the most sanguine expectations of its projectors. In like manner has the

great salmon "Bonanza" of the McLeod River been discovered by Mr. Stone, where immense works have been erected. From each of these establishments millions of eggs and fry are being distributed annually throughout all parts of the Union. Over and above this public recognition, many millions of dollars are now employed in the work of fish culture from private sources by the people of the Republic.

It may not be amiss to state that, within the same period of time, in no country has fish culture made greater progress then in the Dominion of Canada. From its first inception at Newcastle, in the Province of Ontario, it has made rapid strides throughout America. Its operations there have ensured the artificial propagation of the more important commercial fishes of this country, and at the present time, through the wisdom of the Canadian Government, there are no less than five salmon breeding establishments founded within its territory, all of which are in practical working condition, each with a capacity for containing many millions of ova. Other institutions of a similar nature are also in contemplation of being built during next season by the Canadian authorities.

Reference being made here to the Newcastle fish breeding works in Ontario, it will not be taken in the light of self-laudation for me, the sole originator of that institution, to state that from it has sprung all of the national and State fish breeding establishments on this continent.

Fish culture having now become both a popular and successful industry in the United States and Canada, it is of importance that it should be vigorously carried on. The once many famous rivers in both of these countries have now become very much reduced in their supplies of salmon and other fish. This falling off is also experienced in the countless lakes and their innumerable tributaries everywhere throughout the land. Both demand early attention in order to prevent the final extermination of an article of food which it is now almost impossible to sustain in the natural way alone. A judicious application of the natural and artificial methods of propagation, together with thorough protection during the close seasons, would soon reproduce in those waters a large supply of fish, both for domestic purposes and foreign trade. The outlay required to achieve this object will be found to be trifling indeed in comparison to the ultimate benefits that would assuredly flow from its application.

Having made a few remarks upon the question of fish culture in a general way, it will not be amiss to refer to the necessity of wise legislation for the protection and preservation of fish at certain seasons of the year, more particularly during the close or spawning season.

The sea fisheries, from the unlimited field which they cover, and the extensive area in which the natural production of fishes is carried on, do

not require such peculiar laws for their preservation, or for close seasons being set apart for spawning, as are necessary in the inland fisheries.

There is a period when fish are in season, and when they should be taken by legitimate means. There is another period when they are out of season, and then should be protected by all legitimate means. They are in season after they have fully recovered from the prostrating and exhaustive effects of spawning, and when found upon their feeding grounds putting fat upon the body. At this time, though the eggs and milt are in the ovaries, they are so minute as to take little if any nourishment from the system, all of the food taken forming fat and muscle. They are out of season when they have left their feeding grounds, and have reached their spawning beds, and are in the act of spawning. The eggs and the milt at this period having absorbed from the body of the fish most of the fat which had been previously put on, becomes enlarged to the full size, and are mature and ripe for being deposited.

In the egg will be noticed a fatty substance, resembling small globules of oil, which is provided by nature for the nourishment and growth of the embryo fish during incubation, and is the food contained in the sac attached to the young fry for several days after emerging from the shell. This drain of fat from the parent fish into the egg and milt, and the prostrating effects of spawning, causes it to become lean and lank in condition, and therefore foul, out of season, and actually unfit for food. The killing and eating of fish at this particular period should be strictly prohibited by law. It is not less repugnant to common sense than it would be to kill our domestic animals in an advanced state of pregnancy, or for some time afterwards. Why, then should people conjure up the belief that fish do not come under the same laws of nature as other animals?

It is also of importance to remember that nearly all fish, during the spawning season, become very dull, and are in a semi-lethargic state, and, generally speaking, consume little or no food whilst performing this work of nature. Salmon eat nothing whatever at this time, neither do they take food within their stomachs from the time of leaving salt water till after they have performed the work of spawning, even should the time of their migration extend over a period of six months, or longer. At the end of their long journey, and from eating nothing since leaving the sea, they become changed in color, their former rich red flesh now becomes a flabby white, their bodies are frequently covered with wounds and sores, parasites begin to prey upon them, a fungoid growth sets in, and great numbers die.

Mankind, from his overweening selfishness, is not satisfied with killing these fish in the earlier seasons, when they are fat and wholesome, and

well adapted for food and commerce, but would (were it not for an interposition of some kind) relentlessly pursue and kill them up to the close of the year, whilst in the very act of spawning, and in the foul condition just related. It is also to be noted that at this time salmon, from their sluggishness, and from having resorted to the smaller streams on shallow, gravelly beds, become more easy prey for their lawless pursuers, who care nothing for nature's command to "increase and multiply," nor object to foul and unwholesome food, kill indiscriminately, with every sort of device, every fish that may be found. This barbarous practice, having hitherto so generally prevailed, has in numerous instances totally exterminated many of the better kinds of fish from most of the waters of the older settled parts of Canada and the United States.

Many persons are very skeptical as to the actual necessity for close seasons, or any other protection for fish, and consider legislation on the subject altogether superfluous. They know nothing of their habits and nature, beyond the fact that they form delicious food, and cannot therefore see why they should not be taken and eaten at all times and in all seasons. In order that seasonable and wholesome fish may be had in our markets and at our tables at all times and at all seasons, nature has made this wise provision, namely: That the spawning season is not at the same time of year with all fish; some kinds of fish collect in shallow waters and in rivers to deposit their ova in the Spring months, and others in the Fall. By this means a succession of fish can be taken in season throughout the whole year. It only becomes necessary, then, that wise and discriminating regulations should be made to assist the laws of nature, to give to the people of this country, not only for the present time, but also for the future, a bountiful supply of wholesome fish food.

From the few facts just mentioned respecting the nature of salmon and other fish, and the tendency in man to destroy them, it is easy for any person possessing ordinary intelligence, and not selfishly prejudiced to the contrary, to infer how necessary and important it is that all fish should be protected by proper legislation at proper seasons, and also that all persons should be legally prohibited from killing or selling that which is foul and unfit for food.

Having explained the great necessity for passing laws in relation to the preservation of fish at certain seasons of the year, it will be necessary now to meet the question, Why resort to artificial means for the propagation of fish; why not allow them to produce their young in the usual way?

In contrasting the artificial with the natural method, the superiority of the former over the latter system will be easily understood, even by the

great masses of the people, who are as yet wholly uninformed as to the novel science of artificial fish culture, not long since introduced into the country.

It has been advanced by naturalists of an early period, and upheld by eminent writers of modern times, that not more than one per cent. of the ova laid in the natural way ever becomes a living fish. But in the present day it is possible, by artificial propagation, to rear from eighty to ninety living fish from every hundred eggs, which larger increase is actually needed for restocking the waters of the country with fish of such various kinds as may be required in various places, and for supplying in part the increasing demand in the markets of the country for fish food.

As we have chosen to illustrate the necessity for legal enactments for the protection of fish by introducing the salmon, we shall continue to take the same fish for an example while we explain the *modus operandi* of laying and hatching out of the fish spawn in the natural way, and relate the many difficulties which beset the eggs at the time of their deposit by the parent fish, and through the process of incubation, and until they are hatched out in the rivers or other waters. It may be observed that these operations are performed at different times and places by the various kinds of fish.

Salmon, after leaving their feeding grounds, will, after the somewhat lengthened migration previously mentioned, reach their spawning grounds far up river, or, in some instances, if very late in the season, near at hand above tideway. A suitable gravelly bottom, rapid part of the stream, is selected, where the female fish commences, by writhing movements of her body, to displace the stones and gravel in order to form the bed in which she may lay her eggs.

In this work she is very much aided by the swift current of the water, which helps to move the gravel down stream that is being displaced by the exertions of the fish. In this way a hollow spot is dug out, and a small hillock of stones is formed just below. Into this scooped-out bed the fish, by contortions and strong muscular action of the body, ejects a portion of the mature ova, many of which sink to the bottom amongst the gravel, whilst numbers are carried below and far beyond the bed by the current. The little ledge of gravel just above the bed is again disturbed, and the stones in the act of falling are, by the action of the fish, assisted by the swift water, carried down over the eggs, thus partially covering them, and hiding many of them from sight, and also from many of their numerous enemies.

This operation of spawning will take from two to three days to a week, and sometimes longer, depending much upon the lateness of the season, and also the flow of water in the stream at the time. Should the season

be dry, and the water low, the fish will rest in the deep pools below, waiting for the water to rise in the rapids, that they may be enabled to get upon the shallows to form their beds.

All this time the eggs are maturing, and at last, late in the season, unable to retain the ova any longer, they will rush up at the first freshet, and in some instances lay the whole of their eggs in one or two nights.

During the time in which the female is engaged in depositing her eggs, she will generally be accompanied by a male fish, who performs very little, if any, of the labor in forming a bed; he is constantly hovering about just below the female, and when she is in the act of laying her eggs he will run alongside, and, by a muscular movement of his body, eject some of his milt, which, if perchance it touches the egg, impregnates it.

It does not necessarily follow that the female shall be accompanied by the male in the act of spawning, for often it is found that she will lay her eggs without the presence of a male fish. It frequently happens that whilst she may be deeply engaged in her work, several male fish will be fighting together to gain the superiority of place. Whilst thus engaged, the female, bent upon her work, is depositing her ova without the vivifying fluid coming in contact with them. Whilst this operation of laying the ova is going on, the bed is generally surrounded by various kinds of small, predacious fish, watching every opportunity to prey upon the eggs as they flow from the female, or as they settle in the bed or drift beyond it.

Trout cause great havoc in this way; nor is this fondness for the eggs to be laid to the trout alone, for young salmon (parrs), chubs, eels, and almost every other kind of small fish, are lying in wait to perform the same act of destruction of the ova. It is a mere matter of mastery which shall get the lion's share.

Those of the eggs that shall have escaped these perils, together with those that have received the fecundating fluid, will be found embedded in the gravel, where they remain (should they escape all other dangers) during a period of from five to six months of the coldest season of the year, namely, from October till the following April or May. Various kinds of insects, water bugs, and innumerable aquatic animals, whose nature it is to lie hidden underneath the gravel and stones at the bottoms of streams, whilst groping about for food, come upon these salmon beds, and, perforating the soft, filmy covering of the egg, with their needle-like teeth and sharp claws, destroy vast numbers of them.

Add to this a great number lost by decay, for all those which have not received the vitalizing fluid die, and, becoming putrid, there grows upon them a species of fungus, which, spreading its grasping web, catches in

its poisonous folds any adjoining eggs, killing them at once. This insidious growth works great destruction to the semi-incubated egg. Clusters of a hundred and more are thus sometimes found in the crevices of the larger gravel in a putrid state. This great scourge of the ova is very difficult to overcome, even in the purest water, and where the greatest attention is given to prevent its growth.

Another great loss of the ova takes place during the long and inclement winter months, from the formation of anchor ice, which, in shallow parts of rivers and streams, prevails to such an extent as to become one solid mass, in many instances forcing the stream out of the channel in which it flowed during the autumn. The eggs thus having lost their covering of water, become frozen and die. Great destruction is also caused by the shifting and shoving of ice from the effects of heavy freshets. Whole sections where salmon beds had been made are sometimes swept away, and become so changed as to leave no vestige of their original formation.

The remnant of the eggs which may have escaped destruction from the above mentioned sources will in April and May hatch out and become young fry. At this time they are helpless in the extreme, lying prone on their sides, with a large bag or umbilical sac attached to their bodies. In this stage of their existence they remain about five or six weeks, until by a process of absorption, brought about by an increased warmth of the water in Spring, the sac hitherto attached to the body disappears, and the little fish, now symmetrically formed, begin to roam about in a lively manner in search of food. From the time of emerging from the shell up to the present time they are still an easy prey for their numerous enemies.

The difficulties above enumerated, which beset the egg from the time when it was first laid up to the period of its hatching out into a young fish, though somewhat numerous, are by no means all that it has to encounter. There is to be added the destruction by aquatic birds, polluted water, deleterious substances of various kinds, which are constantly thrown into the streams from manufacturing establishments, saw dust and rubbish from saw mills, washings from barn yards and turnpike roads, natural and artificial manures, and other foreign substances used upon the soil in farming, draining, etc. All flowing more or less at times into the streams, and settling upon these beds, so pollute the water and otherwise injuriously affect them, as to cause immense losses to fish eggs, and also to the newly hatched out, and as undeveloped and very delicate fry.

Of the eggs thus deposited, scarcely one in a hundred ever produces a living fish. Yet withal, fish are so prolific in their nature that there

would still be enough for supplying the waters in abundance, and also a sufficiency to relieve the wants of a considerable portion of mankind, were it not for the ruthless and barbarous manner in which they are killed by man, irrespective of the seasons in which they are foul and unclean for food, and of the time also in which they are in the act of laying their eggs for producing their young.

Having now shown the manner in which the ova are laid by the parent fish in the natural way, and described the numerous sources from which great destruction results to the egg by that system, it will be necessary to fully explain the method adopted by the artificial propagation of fish.

For this purpose we will commence at the time at which the parent fish shall have reached the spawning grounds in the river or other water, and when the ova and milt have become mature, the eggs are then taken from the female by the operator in as gentle and careful a manner as possible. There are three methods practiced in securing the adult fish, male and female, for this purpose. One is to catch them by means of nets whilst they are upon the shallows, and if, found ripe at the time, to then and there carefully extract the ova and milt from them. This will be found a difficult procedure, both in the netting of the fish, and also in the uncertainty of afterwards finding them perfectly ripe for spawning, and should not be adopted unless it be impossible to procure them by other means. Another plan is to catch such numbers of the adult fish as may be required at the time of their migration up rivers during the summer months, by means of small meshed nets, and carefully put them into ponds or enclosures, and there securely kept until they become mature for laying their eggs. The other method, which from the beginning has been used at the Newcastle establishments in Ontario, is by erecting a reception house alongside of the stream (through which a sufficient body of water is made to pass), into which the parent fish, on their journey up stream, are enticed to enter through peculiarly formed traps, from whence they cannot return or escape.

This building is divided into several compartments, and the different sexes are placed in different pens, so that they can be more readily noticed and selected for manipulating purposes. When they are found to be ripe, a female is taken out of the water and held over a tin pan or other vessel, and the eggs are extracted from the vent by a gentle pressure of the hand lengthwise along the abdomen. A male is then taken, and the same operation is performed, and the milt or semen which is taken from him is mixed with the eggs in the pan by gently stirring together with the hand, or by a tremulous shake of the vessel. By this means every egg will have come into contact with the fecundating fluid of the male, and unless from some natural defect, either in the egg or the milt,

all of the ova will become impregnated. The pan or vessel containing the eggs is then laid aside for a short time, and in order to ascertain the quantity they are measured out by means of a little measure, made to contain a certain number, and then placed upon the breeding trays; they are then laid in the hatching troughs, through which a constant flow of water from the stream is made to run. Here the eggs are allowed to remain during the whole period of their incubation, namely, from October and November till the following April and May.

During this time they are closely watched, and should any of the ova, from want of impregnation, or from any other cause, become bad, they will turn an opaque white color, and being easily noticed are removed by means of forceps, or other instruments adapted for the purpose. Should these white, or dead, eggs be kept too long, they will become putrid, and a fungus will begin to grow upon them; this would seriously affect and destroy all adjoining eggs.

Should any sediment or other deleterious substance settle upon the ova during the time of hatching, it is immediately washed off by sprinkling water upon them with an ordinary gardener's watering can. By this means they are kept clean and free from filth of all kinds. No frost is allowed to penetrate the building, and the flow of water is regulated at pleasure by taps leading into each of the series of troughs throughout the entire building. At the entrance of each trough perforated screens are placed to prevent the possibility of small fish entering them. In this thoroughly protected state the ova are kept until the young fish emerge from the shell, generally in April and May, after which time also, and until the umbilical sac is wholly absorbed, they are carefully watched and protected.

In May and June the fry will have become beautifully developed, active little fish, and should be turned into the rivers or other waters which are required to be restocked; or at this time they may be placed in ponds of living water, and regularly fed until they become parrs, and afterwards smolts. At this latter stage they make their first migration to the sea, or other large body of water, where they become grilse, and afterwards salmon.

The *modus operandi* pursued in the artificial impregnation of fish eggs and the rearing of fry being somewhat minutely described, it only remains now to draw a contrast between the natural and artificial methods of propagating fish. In the latter there is no possibility of losing either the egg or the milt by being swept out of or beyond the pan or artificial bed in which they were placed by hand, as would be the case when laid by the parent fish in the rapid waters of rivers and streams. In the one case a few moments will suffice to relieve the fish of the whole burden

of eggs which she carries in her body, when she is set free and at liberty in the river; in the other, days and weeks, sometimes, are occupied in the prostrating effects of laying the eggs.

It will appear equally clear that every egg put in the pan or vessel must necessarily come in contact with some portion of the vitalizing fluid of the male, and become impregnated, whilst great numbers that are laid in the streams by the female, without the presence of the male, are wholly lost. Neither will there be found in the artificial beds hoards of predacious fish, waiting eagerly to devour the eggs as they are dropped; nor will trout, parrs, chubs, or eels be found there, seeking which may get the lion's share; and aquatic birds cannot gratify their appetizing desire for fresh eggs within the precincts of the breeding room. Again, the ova are not subjected to injurious bruising and crushing from stones and gravel falling upon them in the act of being laid in the rough bottoms of streams. This danger is avoided in the artificial breeding beds, where neither stones or gravel are used or permitted, the eggs being placed upon smooth perforated zinc or wire, or glass trays in single layers, and not in clusters.

During the six months in which the eggs are undergoing the process of hatching, no insects, water beetles, bugs, or aquatic animals constantly on the alert for food in the gravel beds of rivers, can possibly attack or perforate the fish eggs in their snug and well protected beds in the artificial breeding room. Clusters of dead ova, spreading their insidious fungoid growth to every adjoining egg, are not permitted here, for when the ova presents the white opaque color of death it is immediately picked out and cast away by the person in charge, and all fungoid growth thereby stopped.

The baneful effects of all kinds of sediment and of deleterious substances from mills, manufactories, manures, etc., are all regularly and systematically cleaned from the eggs when resting upon them; neither anchor ice, nor ice floes, nor freshets, destroy or sweep them away when thus properly cared for. Here, from the fostering care and protection afforded them, a vastly greater number of eggs produce living fish. Well may it be said, that "from the cradle to the grave, the salmon has but one constant succession of remorseless enemies," and "that not exceeding one per cent. of the ova laid in the natural way ever produces a living animal." Contrast these statements with the artificial system, and the gratifying result is an increase of at least seventy-five per cent., and even this average is overcome at the present time at the several Canadian and American fish breeding establishments, where, at their commencement a few years ago, only thirty and forty per cent. were obtained; but now, from the close application and well devised experi-

ments, ninety per cent of the ova laid down has produced living fish and not in small numbers either, but amounting in several instances at some of these establishments to millions of fish in one season.

These statements, founded as they are upon facts, ought to show clearly, even to the hitherto doubtful and prejudiced individual, the great superiority of the one system over the other; and when it is shown by the application of ordinary intelligence and industry an increase of seventy to eighty per cent. of one of the natural products of the waters of the country can be brought about by this improved method, it ought not to be viewed in any other light than that of wisdom and economy on the part of the people and the governments of Canada and the United States to generally adopt it.

Perhaps in no part of the globe can there be found so wide a field for successfully carrying on this new industry of propagating fish, both by natural and artificial process, as in the territory of the United States and in Canada. The limpid waters of the many large rivers and multitudes of smaller streams, the immense inland seas of pure fresh water and the numerous inlets and bays to be found everywhere along their extensive maritime coasts, are sources for yielding wealth that cannot be surpassed. And now that the people and the governments are becoming more alive to the great benefits which are to be obtained from the inland and coast fisheries of their respective countries, every effort should be put forth by those in power not only to sustain, but also to increase and multiply the products of those extensive nurseries by a vigorous application of such means as will best conduce to the growth and expansion of the piscine wealth of the two countries.

FISH CULTURE ON THE YANG-TSE-KIANG—THE SAMLI, OR CHINESE SHAD.

BY G. H. COTTON SALTER,

Ex-United States Consul to the Treaty Ports of the Yang-tse-Kiang, China.

In 1862 I occupied 150 days in going from New York to Shanghai in the "Ocean Charger"; to-day, thanks to the steam lines, we can connect the two cities in forty to forty-five days. As we approach the China coast we find the water very muddy, caused by the vast flow of the

Yang-tse, carrying with it an immense amount of earthy deposit. In fact, islands are formed and new shoals are discovered every year, necessitating constant surveys of the channel.

I should call the Yang-tse-Kiang not only the great shad river, but the great fish river of the globe; so vast and of such majestic proportions, that the Chinese familiarly and poetically speak of it as the "Child of the Ocean." I have explored it in my little yacht, the "Faustine, about 1,000 miles from its mouth.

I believe Prof. Baird, of the Smithsonian Institute, and the United States Fish Commissioner, has in view the stocking of the Mississippi with shad; but the question has arisen, Will the shad ascend the river to any great distance, in view of the very muddy character of the water? I reply that the Yang-tse-Kiang is very muddy, the color of thick pea soup, yet the *samli* (shad) we found there in great numbers. They are of superior flavor, of great size, are held in great favor by both rich and poor, and are sent from the river to all parts of the vast empire in large vessels, made of earthenware, called *cangs*. The Chinese have a very ancient custom of sending the first large shad of the season to the Emperor at Peking, and the custom requires that the Emperor should send the lucky fellow a hundred taels of sycee (silver), about $150 gold.

The people of China hold in great reverence anything in the way of fish, flesh or fowl, which contributes largely to their support, and they ascribe especial virtues to the medicinal properties of the oil of the shad, considering it almost a specific for affections of the air passages, and in its early stages, a positive cure even for consumption.

I will remark here that agriculture is looked upon in China as a most exalted calling. Once a year the Emperor visits the Temple of Agriculture, at Peking, a building on a stupendous scale, takes a golden plough and makes a long furrow. This old custom is intended to convey to the minds of all the people the idea that the tilling of the soil is a pursuit fit for an Emperor. Next to agriculture, my researches show they place pisciculture. They give it this place because the proper study of it, the constant stocking of the lakes, the rivers and streams with fish, supplies the vast population—estimated by many geographers at 500,000,000 of souls—with an abundance of healthy food, keeps them contented with their lot, and therefore prolongs their lives and their spheres of usefulness. I have had the *samli* served on my table nearly 1,000 miles from the Pacific Ocean, while sailing on this great river. This, I believe, will be considered an important fact, as showing the probability of stocking our great rivers at long distances from the sea.

The dense population of the empire has stimulated ingenuity to the highest degree, and it is fair to assume that, with a continuous

experience of at least forty centuries, they must have discovered and put to practical use all the methods and appliances of pisciculture as practised by the Caucasian race. I am aware that European and American scientists hold fast to the theory that we are wholly indebted to Jacobi, of Hoenhausen, and after that to Joseph Remi, of Bressi, for the theory as well as the practice of artificial impregnation; but I believe the Chinese discovered, centuries ago, the same system of manipulating the ova and the milt by artificial methods. The Chinese show wonderful ingenuity and inexhaustible patience in securing the eggs after impregnation, in raising the infants, and in filling the lakes, rivers and streams with the best and most profitable species, as well as sending the fish to the most distant portions of that vast empire of eighteen provinces, any one of which has a population perhaps greater than the whole United States. They are very particular about catching their food fish; if small ones are caught, they are returned to the water to increase. This is the effect of long custom, to them more powerful than any written code; they save where we waste. They have several ingenious methods of driving the fish to the nets by arranging a cordon of boats at one end of the pond or lake, and beating tom-toms and gongs in unison, so that the finny tribe, alarmed by the din and noise, swim away from it, and are caught in the meshes of the nets at the other end. The practice of employing that unwieldy bird, the cormorant, as a fish catcher, is curious as well as original. To describe the process would take up too much of your space.

It may be proper to ask here, Of what use is all this labor in stocking our exhausted water-courses with fish, if we still permit all the scourge of our cities and towns, all the liquid poisons from our manufacturing establishments, to kill the fish after you have taken so much pains to hatch them? Mr. Seth Green and Mr. Fred Mather have spoken well and vigorously on the subject. Our laws are notoriously defective, yet the Chinese show the greatest care in keeping the waters free from taint and poison. There the all-powerful custom, the unwritten law, deeply graven on the hearts of the people, is all sufficient, hence their rivers are probably as full of fish to-day as they were 4,000 years ago. We, with the recklessness that characterizes our race, introduce the foul filth of our sewers at our very bed sides, through the vents of our marble basins. We pour all this liquid excrement into our rivers—millions on millions of tons every year—which, if placed on our fields, would make the waste spots bloom with beauty, and then we send to the Chincha Islands for guano. We call our race civilized, and the Mongolian savage. In China, every atom of this human excrement, as well as the deposits of animals, is saved. It is carried away from the houses each

day, and in adjacent villages the earth system is carried on, and has been carried on for centuries. The intelligent foreigner in China is constantly amused at the claims of these so-called modern inventions—earth closets, for example. In the curious boat life of the empire—thousands born, living and dying on boats—you will see the same care of the excrement, liquids and solids being saved and sold. In the valley of the Yang-tse, under this system, three crops are raised during the year; in fact, in no other way could the vast mass of people exist.

I may mention as an equally curious, instructive and interesting fact, the artificial incubation of fowls, carried on in every village of the empire. You meet flocks of tiny geese and ducks going to water led by little boys, with the familiar bamboo wand, and another flock of small chicks, numbering a hundred or more, going to pasture led in the same way. In fact, there is wonderful accord between the beasts of the field, the birds of the air, the fishes of the sea, and the average Chinaman, who, patient and plodding, talks to all these creatures of God's vast domain, and brings himself to their level, or they rise to his, in a way utterly unknown to the more fiery or more aggressive Caucasian.

The amount of phosphorus contained in certain fishes used for food has led many scientists to assume that a fish diet has a tendency to increase the activity of the brain, and hence is the only suitable diet for persons who tax the brains cells for long and continuous periods. This, I think, was a favorite theory of the great naturalist, Louis Agassiz, and many persons believe he was the author of the theory. I found in China that the literary class believed that a farinaceous and fish diet was more suitable for them than one composed of flesh; that while the former supplied the waste of the system as well as nourished it, the latter made the blood gross and heavy, and hence unfitted the system for severe mental toil.

I once visited a high official, living on the borders of the famed Tungting Lake, the great lake of China. His home was about 800 miles from the Pacific Ocean, in the very heart of the empire. After partaking of his generous hospitality, and smoking the pipe of friendship, I asked him if the Chinese philosophers of the ancient days attributed any special properties to a fish diet as a brain producer and brain invigorator. He smiled pleasantly, and begged me to follow him to the Hall of Ancestry—the sacred spot—the temple in the house of every Chinese gentleman in good circumstances. The walls were covered with numerous lengthy scrolls, commemorating the virtues of his long line of ancestors, going back, as he told me, to a period long before the birth of Jesus Christ. "Here," he said, pointing to an ancient scroll, "is one of the tablets our family hold in especial reverence. It tells the story of one whose life was devoted to the poor, the sick, and the distressed. He

was a great philosopher, a great scientist, and a great astronomer, and among his most literary productions was one on the 'Uses and Abuses of Food.' He gave a special chapter to fish diet, and maintained that it was particularly adapted to students and men of letters." The theory of Agassiz is a very old one, and I was often reminded in China of the trite adage, "there is nothing new under the sun."

The society, I believe, are aware that I propose to return to China with a view of a thorough exploration of the Yang-tse Kiang, and I hope to send the American Fish Culturists' Association some interesting facts about the *samli* on the upper Yang-tse Kiang. I believe I shall find the fish three thousand miles from the Pacific Ocean.

ON THE ACCLIMATIZATION OF THE MICHIGAN GRAYLING IN EASTERN WATERS.

BY THADDEUS NORRIS.

In considering the practicability of the project, it is of importance that we bear in mind the peculiarities of the waters the grayling naturally inhabits, and the characteristics of those into which we would introduce it. Let us in the first place, therefore, refer to the streams which are its present habitat.

That portion of Michigan lying between the two great lakes, and extending from the 44th parallel to the straits of Mackinaw, is nearly level, or at least but slightly rolling. There is a gradual but almost imperceptible rise of some six or eight hundred feet from the shores of either lake to the highest points of the interior of the State. The surface, and for many feet down, is of coarse loose white sand, and underlying this, as far as my observations have enabled me to judge, is a stratum of tough clay. There being but little water shed, it is natural to suppose that the rains quickly percolating through the sand, and being arrested by the impervious clay, necessarily form small underground water courses, which in greater or less volume find opening into the rivers and creeks. These rivulets, as a general rule, are so far beneath the surface as to be but slightly affected by the heats of summer or frosts of winter. The water of the streams may therefore not inappropriately be termed "spring water," and are of very uniform temperature, cold—so to speak—in summer, and never freezing over in winter.

Many of the grayling streams—and there are few without them—have their origin in lakes abounding in pickerel, bass and yellow perch; and although the outlets are as warm as the lakes where they debouch, the temperature is so quickly reduced by the small affluents already mentioned, that in a short distance they become cold enough for grayling. Grayling are not found in the lakes, or pickerel, bass and perch in the streams flowing from them; and a somewhat anomalous fact is that trout are not often found in the grayling streams—grayling, as a general rule, being almost the only fish of any importance. In water of such uniform temperature, insect life is abundant at all seasons—the work of procreation being kept up as well in winter as in summer. One of the few instances of this kind in the east can be observed in Caledonia Creek, in the State of New York.

In that part of Michigan where grayling are found, the country is so nearly level, that the banks have but a few feet elevation above the surface of the streams, so that they appear bank-full; and there being but slight water-shed, they are subject to but slight rise or fall—pursuing their courses with strong, but smooth and uniform, flow.

Such are the natural homes of the grayling; and although I would not discourage a rigorous prosecution of the experiment of introducing it in the east, where, in our part of the Union, I would ask, can we provide it such habitat? Certainly not in our rocky, mountainous regions, where we go for trout, or in the Adirondacks, or in Maine or New Hampshire—the only waters we have at all like those of Michigan, and the few streams flowing from large limestone springs.

In many respects the habits of the grayling are the reverse of those of our trout. The former spawn in April, the latter in November. The trout will wriggle into the smallest tributary, while the grayling spawns uniformly in the wide open stream. As to its excellence for the table, it does not compare with the trout; as a sporting fish, it is not a whit inferior. To run the Au Sable, sitting in the bow of a fairy-like shell of a boat, with Len Jewel and his setting pole in the stern, to direct its course, whipping its smooth, rapidly-gliding pools, is the *ne plus ultra* of fly-fishing.

ON THE PENNSYLVANIA FISH-WAYS.

BY JAMES WORRALL.

During the early spring and summer of 1874, we carefully observed the working of our structure. We have no doubt at all but that large numbers of shad passed through it during high water in the Susquehanna. At least three thousand shad were caught above the Columbia dam in the Susquehanna river during that season. This being of course but a small percentage of the number of fish which actually crossed over the dam.

During the fall of 1874 large quantities of the small shad, which were the hatching of the spawn deposited above the dam by the fish which made the transit during the last summer, were constantly seen making their way down the stream to the sea. We are consequently led to believe that we have attained a measure of success in the erection of our fish-way as a transit for shad in advance of any that has ever been reached in the history of fisheries in this country or the old world. We are firmly convinced that our fish-way, as it stood in 1874, was operative in a high stage of water; we are just as firmly convinced that during a low stage of water our fish-way was inoperative and inefficient. During the fall of the past year we attempted the alteration of the fish-ways so as, if posible, to make it available for the purpose of allowing a free transit of shad at all seasons and at all stages of the water. To accomplish this we had the floor of the fish-way torn up for the distance of 100 feet and lowered, so as to carry the toe of the fish-way considerably below the surface of the water.

The run of shad in the season of 1874 commenced on the 11th day of May, and fishing, to any considerable extent at Havre de Grace, the mouth of the river, ceased on the 20th. Thus making the run of fish but a little more then a week from which the entire upper river was to have been supplied. Rain did not occur in this region until late in June or until the beginning of July. So drouth may be said to have set in at that early day, even during the fishing season. The river at once commenced falling, and the result was that the reaction natural to low water occurred whilst still the fish were running. The stage that low water reached was lower than that seen in many years. This state of the water left the toe of our fish-way on a level with the water in the pool below the dam. The water descending the fish-way, acquired sufficient velocity to make a deep hollow in the water of the pool below, and to create a large reactionary wave. This reaction undoubtedly

prevented the ascent of any fish in that stage of water. We therefore deemed it advisable to alter the work so as to remove this objection. The plane or floor was torn up, and the toe of the fish-way lowered about two feet six inches, so that it should be below the lowest water that had occurred in the river for the last half century. While this operation was being performed, the abutments or side walls of the fish-way were strengthened by increasing their thickness. This was done at the desire of the company owning the dam, who thought the work somewhat endangered by leaving them at the old dimensions, and the law prescribing that the dam was not "to be injured for the purpose for which it was constructed," by the introduction of the fish-way.

In addition to this, the flooring of the fish-way was purposely roughened to give it more the character of the bottom of the stream. On each side of the deck or floor a space of ten feet was paved with rough stones, and the middle of the flooring was interspersed with piles of slab and plank placed at irregular intervals, so that the water, in passing through, should have a likeness to an interrupted current of a natural fall.

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